CLAIMS

1. A noise control system comprising:

a primary sensor means arranged to detect a primary sound from a primary source and provide a first output signal indicative of the primary sound, which output signal has a frequency spectrum;

a sound producing means arranged to produce a secondary sound usable to cancel the primary sound;

an error sensor means arranged to sense a difference between the primary and secondary sounds and provide a second output signal indicative of the said difference;

a signal processing means arranged to receive and process the first and second outputs to produce a third output to be received by the sound producing means and used to produce the said secondary sound,

wherein the spectrum output from said primary sensor means is arranged to be divided into a plurality of frequency pass-bands, each frequency pass-band being arranged to feed a finite impulse response filter using an adaptive algorithm acting on the second output signal, and wherein each finite impulse response filter is arranged to produce an output signal, which output signals are combinable to produce the said third output signal.

2. A noise control system according to claim 1, wherein the adaptive algorithm acting on the second output signal is a least mean squared algorithm or equivalent.

3. A noise control system according to claim 1 or claim 2, wherein the sound producing means is arranged to adapt the secondary sound to the primary sound in a step-wise fashion having an adaptive step size adjusted proportional to the square of the amplitude within each pass-band.

4. A noise control system according to any preceding claim, wherein the sound producing means is arranged to modify the secondary sound until the second output signal is substantially minimised within each pass-band, thus tending to maximise the speed of modification of the secondary sound evenly across the frequency spectrum of the first output signal.

5. A noise control system according to claim 4, wherein the speed of modification of the secondary sound is substantially constant with amplitude of the primary sound.

6. A noise control system according to any preceding claim, wherein the adaptive algorithm comprises a control system estimate.

7. A noise control system comprising:

a primary sensor means arranged to detect a primary sound from a primary source and provide an output signal indicative of the primary sound;

a sound producing means arranged to produce a secondary sound usable to cancel the primary sound;

a signal processing means arranged to receive the said output signal, calculate a negative substantial copy of the output signal and use the calculated negative substantial copy to produce an adjustment signal to be received by the sound producing means and used to produce the secondary sound.

8. A noise control system according to claim 7, wherein production of the adjustment signal compensates for control system distortion.

9. A noise control system according to claim 8, wherein the compensation is carried out by any or all of : (i) physically altering the dynamic response of the sound producing means , (ii) mathematically modifying the net response of the system through adding the appropriate poles/zeros to the overall transfer function and (iii) passing the signal through the control system inverse.

10. A noise control system according to claims 8 or claim 9, wherein a control system inverse is used to compensate for control system distortion and is obtained in series with the control system using a training signal derived from white noise or a periodic pulse train.

11. A noise control system according to claim 10, wherein the control system is a non-minimum phase function and a convergence delay is used in parallel with the control system and a training FIR filter to cause convergence of the training process.

12. A noise control system according to claims 8 or claim 9, wherein in order to compensate for control system distortion, a spectrum amplitude of a control system impulse response is obtained and inverted, a phase of the control system impulse response is obtained and

phase negated and the inverted amplitude and negated phase are reassembled as a time domain inverse function.

13. A noise control system according to claim 12, wherein the inversion and negation is carried out using a Fast Fourier Transform and the reassembly is carried out using an inverse Fast Fourier Transform.

14. A noise control system according to any of claims 7 to 13, further comprising an error sensor means arranged to sense a difference between the primary and secondary sounds and provide an error signal indicative of the said difference.

15. A noise control system according to claim 14, wherein the signal processing means is arranged to receive the error signal for use in production of the adjustment signal.

16. A noise control system according to any of claims 7 to 15, wherein the sound producing means is disposed at a predetermined distance relative to the primary source such that sound takes a predetermined time to travel between the primary source and the sound producing means, and the signal processing means is arranged to use the predetermined distance to calculate the adjustment signal.

17. A noise control system according to claim 16, wherein there is a secondary signal processing sample delay associated with the sound producing means, which is useable to set a minimum predetermined distance and, which is offset by a signal advance, produced by positioning the sound producing means downstream of the primary source until the secondary sound is slightly in advance of the primary sound.

18. A noise control system according to claim 17, as dependent on claim 11, wherein a dominant component of the signal processing sample delay is the said convergence delay.

19. A noise control system according to any of claims 7 to 18, wherein the secondary sound is substantially aligned and matched in amplitude with the primary sound by means of an adjustable circular buffer sample delay number and an amplitude adjuster, through successive adjustment.

20. A noise control system according to any of claims 7 to 19, wherein the primary sound and the secondary sound form a phase controlled dipole, where the combined sound directivity is controlled by adjustment of the distance between the primary source and the sound producing means.

21. A noise control system according to claim 20, wherein the propagation distances of the primary and secondary sounds are substantially identical such that the secondary sound is substantially completely aligned at all points along the primary sound, and thus produces a uniform shadow along the primary sound.

22. A noise control system according to any of claims 7 to 21, which produces acoustic shadows that are rotatable from a line joining the primary source and the sound producing means, the rotation angle depending on one or more of :

a secondary signal processing sample delay change; a primary sound sampling frequency; a distance between the primary source and the sound producing means; and the speed of sound.

23. A noise control system according to any of claims 7 to 22, further comprising one or more further primary sensor means and one or more further sound producing means, arranged generally in successive alignment planes or arcs from the primary source and contained within shadow control angles.

24. A noise control system according to claim 23, wherein the shadow control angles extend vertically and horizontally.

25. A noise control system according to claim 23 or claim 24, further comprising one or more error sensor means arranged in the said successive alignment planes or arcs.

26. A noise control system according to claim 25, wherein the geometry of the system is adjusted by varying one or more of:

the number of sound producing means; the number of error sensing means; distances between the sound producing means and the error sensing means; and the shadow control angles,

so as to avoid the path differences between the sound producing means and the error sensing means over the operating frequency range being one or a multiple of the acoustic half wavelength of the sound producing means.

27. A noise control system according to claim 25 or claim 26, wherein each primary sensor means together with a respective sound producing means and error sensing means forms an independent channel, and each sound producing means is individually adjusted to minimise error at its respective error sensing means.

28. A noise control system according to any of claims 25 to 27, wherein the multiple primary sensor means, sound producing means and error sensing means form a group of channels, and the multiple sound producing means are collectively adjusted, under the control of a computing means, to produce a total collective minimum error at the error sensing means.

29. A noise control system according to claim 28, wherein the computing means uses an adjustment filter and a modified filtered algorithm of the output signal indicative of the primary sound, either off-line or momentarily on-line to align the channels and counteract control system changes, thus facilitating a substantially instantaneous adjustment of the secondary sound with respect to the primary sound.

30. A noise control system according to claim 29, wherein the C filter is further used to reduce the minimum distance of the sound producing means from the primary source at which the cancellation of predictable primary sound is achieved.

31. A method of controlling a noise, comprising the steps of :

detecting the noise and providing a first output signal indicative of the noise, which output signal has a frequency spectrum;

producing a secondary sound usable to cancel the primary noise;

sensing a difference between the primary noise and the secondary sound and providing a second output signal indicative of the said difference;

processing the first and second outputs to produce a third output to be used in the step of producing the said secondary sound,

dividing the spectrum output into a plurality of frequency pass-bands, and using each frequency pass-band to feed a finite impulse response filter and thus produce an output signal; and

combining the output signals to produce the said third output signal.

32. A method of controlling a noise, comprising the steps of :

detecting the noise and providing an output signal indicative of the noise;

producing a secondary sound usable to cancel the primary noise;

calculating a negative substantial copy of the said output signal and using the calculated negative substantial copy to produce an adjustment signal; and

using the adjustment signal to produce the secondary sound.